

Hazards of Orthodontics Appliances and the Oropharynx

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Abstract. Occasionally orthodontic appliances or parts of orthodontic appliances have caused problems with either the airway or the gastrointestinal tract. The type of appliances that have caused problems and their clinical management are discussed. A case is described in which an upper removable appliance with inadequate retention became lodged in a patient's pharynx lacerating the palatine tonsils. Suggestions are made to try and avoid the problems that were encountered in this case and others reported in the literature in patients undergoing orthodontic treatment.

Index words: Airway, Oropharynx, Hazards, Orthodontics removable appliances.

Introduction

Incidence of foreign body inhalation or swallowing

Occasionally, orthodontic appliances or parts of them can compromise the airway and gastrointestinal tract due to the close proximity of these appliances to the oropharynx.

The presence of any foreign body in the airway needs to be treated as a serious situation as it can be a cause of accidental death in children (Aytac *et al.*, 1977). Food materials constitute the majority of foreign bodies found in the airway with the highest incidence being below the age of 3 years (Aytac *et al.*, 1977; Blazer *et al.*, 1980). Foreign bodies entering the alimentary canal do not represent such a serious medical problem unless they become impacted or cause perforation of the gut wall as the majority pass through without incidence (Webb *et al.*, 1984; Hinkle, 1987; Ghori *et al.*, 1999).

The incidence of aspiration or swallowing of foreign bodies of dental origin varies considerably in the literature. Tamura *et al.* (1986) in a review reported the range being 3.6–27.7 per cent of all foreign bodies, the number being considerably higher in adults than children. The incidence of reported cases of aspiration or ingestion of orthodontic appliances is less common, but no less varied in the types of appliance involved. These include swallowing of a transpalatal arch during its removal (Absi and Buckley, 1995), a lower spring retainer (Hinkle, 1987), an upper removable appliance (Martinez *et al.*, 1975), a fragment of an upper removable appliance (Parkhouse, 1991), a piece of archwire (Lee, 1992), and expansion appliance keys (Nazif and Ready, 1983).

In the delivery of dental care there has been a trend to treat patients in a supine position to aid access to the oral

cavity, and improve the comfort of the patient and clinician. In this position there is an increased risk of objects entering the oropharynx (Lanning, 1988; Cameron *et al.*, 1996), although it has been suggested that the supine patient is prevented from swallowing, and hence there is less chance of aspiration or swallowing of foreign bodies (Neuhauser, 1975). However, accidents are possible when treating patients in either position (Jacobi and Shillingburg, 1981; El Badrawy, 1985).

Clinical presentation and management

If an object is dropped into the mouth in a supine patient, the patient's head should be turned to one side to encourage the object to fall into the cheek and not the oropharynx (Cameron *et al.*, 1996) or the patient could be turned face down to allow the object to fall out of the mouth (Barke-meir *et al.*, 1978; Killingback and Stephens, 1988). The patient should be asked to cough (Jacobi and Shillingburg, 1981). The mouth and oropharynx should be examined, and if the object is visible it should be removed either with forceps (Jacobi and Shillingburg, 1981) or high speed suction (Israel and Leban, 1984), which should be available during all dental procedures (Cameron *et al.*, 1996). The most readily visible site for entrapment of a foreign body that has become displaced in the oropharynx is the supra-tonsillar recess, followed by the epiglottic vallecula and the piriform recess. If the foreign body cannot be found in these places it should be assumed that it has either been swallowed or aspirated (Scott and Dooley, 1978).

The majority of foreign bodies entering the oropharynx will pass into the alimentary canal (Webb *et al.*, 1984) and

pass without incidence, though there is a danger of perforation of the gut which can have very serious consequences including death (Ghori *et al.*, 1999). In the oesophagus, only large objects and those with sharp edges are liable to become impacted, and if this occurs it is usually at the level of the fourth cervical vertebrae (Hinkle, 1987). Symptoms of oesophageal obstruction are the inability to swallow, muscle incoordination, pain on swallowing, haematemesis, or vomiting. Once a foreign body has reached the stomach it has an 80–90 per cent chance of passing along the gut without problems (Webb *et al.*, 1984; Hinkle, 1987; Ghori *et al.*, 1999). Less than 1 per cent of these foreign bodies have caused a perforation (Gonzalez *et al.*, 1988; Absi and Buckley, 1995). The commonest sites for perforation to occur are the ileo-caecal junction and the sigmoid colon. The symptoms vary between abdominal pain, fever, nausea, vomiting, abdominal distension and diagnosis can be difficult (Gonzalez *et al.*, 1988; Matricardi and Lovati, 1992; Ghori *et al.*, 1999). The usual time taken for a foreign body to transverse the intestinal tract is 2–12 days (Hinkle, 1987). If it is suspected that a patient has swallowed a foreign body, the patient should be referred to the appropriate medical speciality (Wakeen, 1993), as it may be necessary to electively remove an object with sharp edges to avoid perforation (Webb *et al.*, 1984; Ghori *et al.*, 1999). On occasions, patients have been advised to supplement their diet with a large amount of cellulose, which theoretically will aid the passage of the object through the gut (Neuhauser, 1975; Absi and Buckley, 1995). For radiolucent objects, ingestion of cotton wool pellets mixed with small amounts of barium sulphate suspension has been reported to form a radio-opaque bolus around the object, which allows it to be tracked through the gut radiographically (Jacobi and Shillingburg, 1981).

The aspiration of a foreign body during dental treatment presents a serious problem and the symptoms will depend on where the object becomes impacted. If it gets trapped above the vocal cords, acute respiratory distress can result, which requires urgent action. Smaller objects, however, tend to pass through the vocal cords and upper airway obstruction does not occur (Israel and Leban, 1984). The commonest symptoms of laryngotracheal foreign bodies are dyspnoea, cough, and stridor, while those of bronchial foreign bodies are cough, decreased air entry, dyspnoea, and wheezing (Blazer *et al.*, 1980). Hoarseness will accompany obstruction of the larynx or trachea with or without cyanosis depending on whether the obstruction is partial or complete (von Haacke and Wilson, 1986). Initial symptoms can subside, and small foreign bodies may have no initial effects and go unrecognized until later, when secondary symptoms such as pneumonia develop (Aytac *et al.*, 1977). Symptoms of inhalation can also be overlooked when the patient has a history of asthma or when the history of inhalation is obscure (Poukkula *et al.*, 1988). Foreign bodies that have been present for some time can cause abscess formation, pneumonia, atelectasis, or bronchiectasis, and their removal can be complicated by granulation or scar tissue.

Treatment of aspirated foreign bodies is dependent on the severity of the symptoms. If the foreign body is obstructive and the patient is in respiratory distress, dislodgement of the foreign body should be initially attempted with back blows and the Heimlich manoeuvre (Heimlich, 1975; Jacobi

and Shillingburg, 1981; Lanning, 1988). If these fail to dislodge the object, positive airway pressure needs to be maintained by artificial respiration and if this fails to maintain a patent airway, the object should be bypassed and an emergency airway established (Edmondson *et al.*, 1989). The approach recommended is via the cricothyroid membrane and should only be attempted by a medical practitioner with the appropriate training (European Resuscitation Council Guidelines, 1998). Once an airway has been established the patient should be transferred to hospital for emergency medical attention. If the object has passed the vocal cords and there is no obstruction of the airway, the patient should still be referred for immediate medical attention (El Badrawy, 1981; Hinkle, 1987). All foreign objects in the respiratory track need removal and this should be done as soon as possible as oedema, excessive secretions and formation of granulation tissue can make localization and removal difficult (Radford *et al.*, 1974; Israel and Leban, 1984). The mucosal appearance of the pink acrylic often used in orthodontics can also make visualization during bronchoscopy of any fragment of inhaled acrylic difficult and, hence, may complicate its removal (Adelman, 1988; Ong *et al.*, 1988). Although spontaneous expectoration of inhaled foreign bodies occurs in 1–2 per cent of cases (Chatterji and Chatterji, 1972), waiting for this to happen with postural drainage is no longer recommended as the foreign body dislodged from its original location, may cause obstruction of the airway (Aytac *et al.*, 1977).

Case Report

A 9-year-old female attended as a new patient to the Dept of Orthodontics, University Dental Hospital, Ankara, with an anterior open bite and a history of digit sucking. She presented with a Class II division 1 malocclusion on a skeletal 1 base, with a 7-mm anterior open bite in the mixed dentition (Figure 1A). It was thought that the main aetiological factor was the digit sucking, which occurred mainly at night. To eliminate the habit a simple removable appliance was fitted with only osenklammer type retainers (Witt and Gehrke, 1981; Fischer-Brandies and Stahl, 1990), which the patient was instructed to wear full time (Figure 1B).

The patient subsequently attended as an emergency at the Department of Orthodontics approximately 1 week after the appliance was fitted.

She had a history of waking in the night in pain and unable to breathe. Her parents were woken by the sound of her in distress, and looking in her mouth they realized that the appliance had become displaced and had lodged in the back of her mouth, compromising the airway. Their initial attempts to remove the appliance were unsuccessful and only after the child was physically restrained by one of her parents, was the other able to remove the appliance. Following the removal there was considerable bleeding from the patient's mouth.

On intra-oral examination a soft tissue injury in the palatine tonsillar region was observed, approximately 3 mm in length and 2 mm in breadth (Figure 1C). The child was prescribed a course of antibiotics, analgesics, and an antiseptic mouth wash. On review 2 weeks, later healing had occurred and there was no clinical evidence of the laceration.

Discussion

This case report illustrates the ease with which removable appliances can become dislodged if retention is inadequate, and the potentially serious complications to the oropharynx that can arise. Removable appliances are not the only orthodontic appliances that have given rise to problems. Problems have arisen with a variety of appliances, and the following information and recommendations are derived from this case report and those provided by other authors.

The use of a gauze dental napkin as a barrier technique can be very useful when placed behind the orthodontic appliance during its adjustment (Barkemeir *et al.*, 1978).

In some patients, placing molar bands can be difficult, especially second molar bands. To help keep control of bands in these patients and to aid quick retrieval, floss can be tied through the tube in a figure-of-eight design (Figure 2A). Once the band is cemented on the tooth, the floss can be removed. A similar technique has been recommended for the placement of rubber dam clamps (Alexander and

Delhom, 1971; Myers, 1972; Barkemeir *et al.*, 1978). Auxiliaries that are placed on archwires such as coil springs can be temporarily stabilized on the wire during its placement with wax (Figure 2B).

All the components of removable appliances should be smooth and rounded as far as possible. All cribs and springs should not have sharp ends, and finger springs and stops should be rounded (McCabe and Wilson, 1976; Parkhouse, 1991). Hooked or 'C' clasps should be avoided if possible, or alternative retentive components used. This will reduce the risk of puncturing or irritating the lining of the alimentary canal, and make retrieval without further damage more likely in the event that the appliance does become impacted (Hinkle, 1987). As this case report demonstrates, all removable appliances must be suitably retentive and of an adequate size (Knowles, 1991). The lower Barrer-type spring retainers should be incorporated into a full sized lower retainer (Graber, 1987). The use of spoon dentures should be avoided due to the small size and poor retention (Chandler *et al.*, 1971a,b; Stafford and MacCulloch 1971). The use of different coloured acrylics, rather than pink, for



FIG. 1 (A) Intra-oral view showing the presenting malocclusion, with anterior open bite related to digit sucking. (B) Upper removable appliance fitted to act as deterrent to digit sucking, retained only by osenklammer type clasps mesial to the upper first molars. (C) Intra-oral view showing two lacerations to the palatine tonsils following displacement of the appliance into the oropharynx.

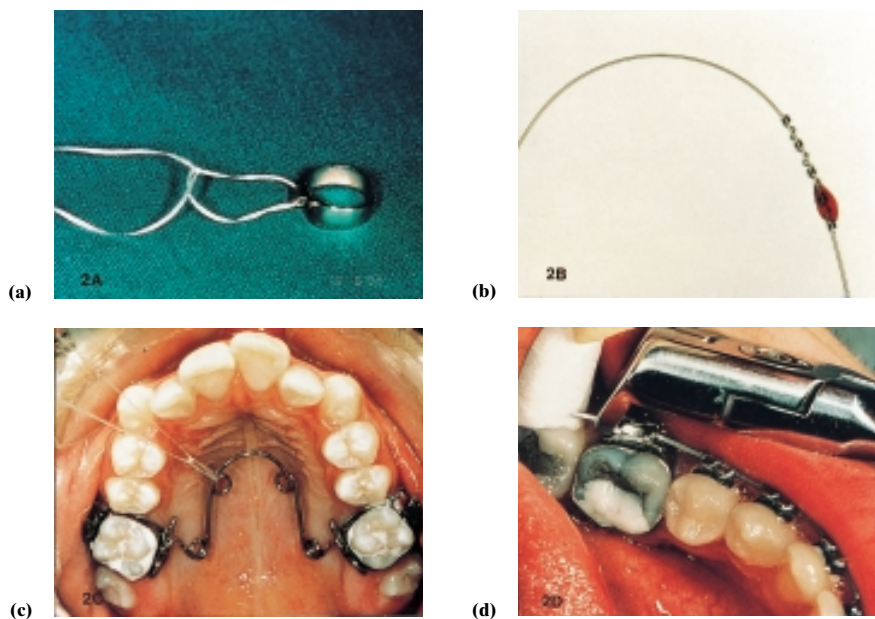


FIG. 2 (A) The use of dental floss to secure molar bands during placement. (B) The use of wax to secure a coil spring during placement of an archwire. (C) The use of dental floss to secure a quadhelix during placement. (D) The use of a cotton wool roll to prevent displacement of wire fragment into the mouth during cutting with distal end cutters.

the construction of removable appliances and retainers has been suggested to avoid problems visualizing the acrylic on bronchoscopy or endoscopy if fragments are inhaled or swallowed (Adelman, 1988; Ong *et al.*, 1988; Knowles, 1991). Patients should always be advised both verbally and with written instructions at the time of appliance placement that they should not try to reinsert damaged, ill-fitting, or broken fragments of any appliance. They should stop using them, and contact the Orthodontist's Office or practise to have the appliance checked (Donaldson *et al.* 1971; Parkhouse, 1991).

Keys for turning fixed expansion appliances intra-orally should be attached to floss and any open contact on the handle of the key should be soldered to prevent the floss from slipping through the handle (Nazif and Ready, 1983). An alternative key that is attached to a plastic spatula is now commercially available and may be a preferable alternative (Shilliday Safety Key, Forestadent).

When fitting or removing transpalatal arches and quad-helices, it may be advisable to have a long length of floss tied to the appliance attached via a closed loop on the appliance to avoid its inhalation or swallowing should it be dropped (Absi and Buckley, 1995; Figure 2C)

The choice of archwire material and grade should not only be dictated by the forces required to move teeth, but also by the ability of the wire to withstand masticatory stresses (Lee, 1992). Where there is a large span of unsupported wire consideration should be given to supporting it with tubing.

When cutting the ends of archwires with safety distal end wire cutters, the pliers sometimes fails to hold the cut fragment. A cotton wool roll placed over the end of the archwire before it is cut will prevent the piece of archwire becoming displaced in the mouth, or embedded in the soft tissues of the patient or operator (Killingback and Stephens, 1988; Perry, 1987; Figure 2D).

All orthodontic instruments that are used intra-orally should be regularly inspected for signs of failure, and replaced or reconditioned on a regular basis (Killingback and Stephens, 1988).

During the taking of impressions the impression material used should have a high viscosity and the tray should be the correct size and fit (Cameron *et al.*, 1996). An upright position for the patient is recommended with clear instructions to the patient. The clinician should be able to visualize the back of the upper tray as it is seated in the mouth so excess impression material is not allowed to extrude into the back of the mouth. The patient should then be advised to tilt the head forward, place their chin down towards the chest, avoid trying to swallow, and if necessary dribble onto a bib placed on their chest. The patient may find it more comfortable to breath through their mouth, rather than their nose while the impression is seated in the mouth.

If a piece of appliance is dropped in the mouth during treatment, the availability of high speed suction with a pharyngeal tip can help with quick retrieval (Israel and Leban 1984).

The role of radiography in localization of a foreign body is related to the radiodensity of the object. If the object is radio-opaque or has radio-opaque components, plain film radiographs can be very useful. If the object is radiolucent it will not be visible on plain film radiographs, although secondary changes around the object may be apparent

(Poukkula *et al.*, 1988). Alternative ways of identification and localization of foreign bodies include computerized CT scanning (Newton *et al.*, 1987; Gonzalez *et al.*, 1988; Ong *et al.*, 1988), and barium swallows for objects impacted in the oesophagus (Absi and Buckley, 1995) and ultrasound (Matricardi and Lovati, 1992). The use of a radio-opaque acrylic has been recommended extensively in the literature over a considerable period of time for use in dental appliances to aid the detection of acrylic fragments if aspiration or ingestion occurs (McCabe and Wilson, 1976; Hinkle, 1987; Newton *et al.*, 1987; Adelman, 1988; Knowles, 1991; Absi and Buckley, 1995). Most acrylics are radiolucent which makes it difficult to locate the acrylic if it is inhaled or ingested with plane radiography (Perenack, 1980; von Haacke and Wilson, 1986; Ong *et al.* 1988; Poukkula *et al.*, 1988).

Attempts have been made to produce radio-opaque acrylic for denture construction. These have consisted of incorporation of radio-opaque bodies (lead foil, amalgam), the salts of heavy metals (barium fluoride, barium sulphate, bismuth glass, and barium acrylate) and the production of co-polymers in which one of the co-monomers contains a heavy atom (McCabe and Wilson, 1976). Unfortunately, the incorporation of these materials into acrylic has adversely affected the properties of the acrylic from the aesthetics to the finish that can be achieved. The incorporation of radio-opaque objects into acrylic tends to set up stress concentrations weakening the material (Chandler *et al.*, 1971a,b).

Barium sulphate inclusion has been found to give good radio-opaque appearance on radiographs at 20 per cent, but the physical properties of the resin were found to deteriorate at concentrations above 8 per cent and the control of the colour of the acrylic was adversely affected (Saunbury, 1964). Where barium sulphate has been incorporated into denture acrylic, the radio-opacity of the material has aided identification, and its removal in a case of an ingested denture and subsequent perforation of the sigmoid colon (Cleator and Christie, 1973). Work done on inclusion of bismuth glasses into acrylic, because of the high atomic number of bismuth and its inertness, showed good radio-opacity, but no subsequent work appears to have been carried out (Stafford and MacCulloch, 1971). A material called Opex appeared in the literature, which appeared to provide good radio-opacity combined with good physical and aesthetic properties, but like the previous material no follow-up investigations or clinical findings have been reported (McCabe and Wilson, 1976). More recently, work has been published looking at the incorporation of a radio-opaque polymer of methyl methacrylate containing bromine, into denture base materials (Davy and Causton, 1983). Inclusion of 36–40 per cent of the bromine-containing co-polymer was reported to give good radio-opacity, while retaining good mechanical properties.

Recently, glitter-containing acrylics have become available. Some claims have been made that the glitter makes the material radio-opaque on a plane radiograph. To test this claim, six similar simple upper removable appliances were made from six currently available acrylics, five of which incorporated commercially available glitter, one of which the manufacturers claimed was radio-opaque (Leonne, Seato Fiorentino, Italy). A similar appliance was made from a radio-opaque acrylic material which is no longer commercially available (Stellon Radiopaque,

Dentsply Ltd; Figure 3). These appliances were then radiographed in air (46 kV 2 mAs direct exposure, fast screen) and through a phantom abdomen (70 kV 8 mAs, fast screen no grid). The results are shown in Figures 4 and 5. It can be seen that one (Stellon Radiopaque, Dentsply Ltd) gave a reasonable appearance in air, but none gave good radio-opacity on the abdominal view.

In 1981, the American Council on Dental Materials, Instruments and Equipment recommended the use of radio-opaque acrylic in dentistry as has a coroner's report following a death resulting from inhalation of a denture



FIG. 3 Seven similar removable appliances constructed of six radiolucent dental acrylics. Five of these contained glitter, one was heat cured and clear, and one was constructed of a heat-cured radio-opaque acrylic. Clockwise from top: (a) Stellon heat-cured; (b) Eurodentics (green glitter); (c) JBC (light green glitter); (d) Leonne (multicolour glitter); (e) Forrestadent (red glitter); (f) Trevlon heat-cured; (g) Forestadent (magic glitter).

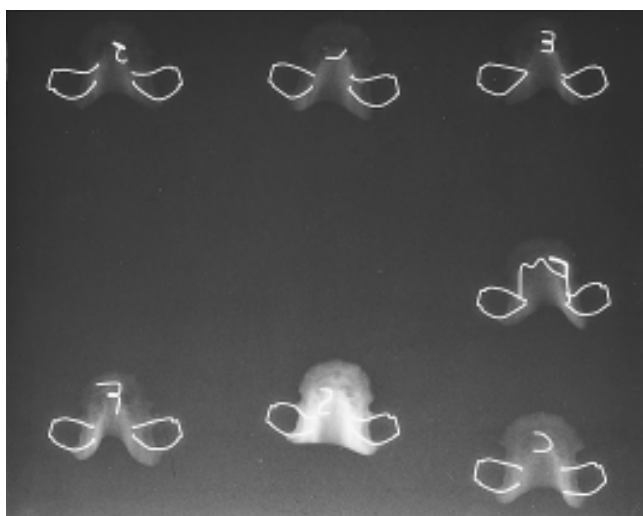


FIG. 4 Plain film radiograph taken of the appliances in air (46 kV 2 mAs direct exposure, fast screen).



FIG. 5 Plain film radiograph taken of appliances through phantom abdomen (70 kV 8 mAs, fast screen no grid).

(Sarginsen, 1991). There are also several reports in the dental and medical literature making similar recommendations (McCabe and Wilson, 1976; Hinkle, 1987; Newton *et al.*, 1987; Adelman, 1988; Knowles, 1991; Absi and Buckley, 1995). Although radio-opaque acrylic has previously been commercially available (Stellon Radiopaque, Dentsply Ltd), to the authors knowledge, there is none presently on the market. Until one becomes available orthodontists are limited to the use of an alternative coloured acrylic to pink or clear in the construction of removable orthodontic appliances, which would make visualization easier on bronchoscopy or endoscopy in the event of accidental inhalation or ingestion of an acrylic fragment.

Conclusions

1. All removable appliances must have adequate retention and regularly supervised.
2. Removable orthodontic appliance design should avoid sharp edges, hooked and pointed wire components, and wire of inadequate size.
3. When a suitable radio-opaque acrylic becomes available, it should be used in the construction of acrylic orthodontic appliances.
4. It is advisable to use an alternative colour of acrylic to 'pink' and 'clear' in orthodontic appliances.
5. In some situations when adjusting small components on orthodontic appliances it would be advisable to use a barrier such as a gauze napkin.
6. Attach floss to a closed loop on loose components while placing them in position intra-orally.

7. If an object is swallowed, seek medical advice, and refer for further investigation and possible early elective removal if there is thought to be an increased risk of perforation.
8. If an object is inhaled and the patient is in respiratory distress, attempt dislodgement with backblows and the Heimlich manoeuvre. If these fail seek urgent medical attention. If the patient loses consciousness maintain positive airway pressure with CPR, until the emergency services arrive. If the patient is not in respiratory distress the patient should be referred for further immediate investigation and removal of the foreign body. Delay can complicate removal.
9. Keep up to date with CPR as the recommendations do change.

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